

CIRPAS Update

Fall ICCAGRA Meeting
November 9, 2009

- New Instrument Capabilities
 - Expendables
 - Cloud physics & aerosol probes
- Mobile PAR
 - Tornado observations
- Twin Otter
 - Overhaul
 - Schedule

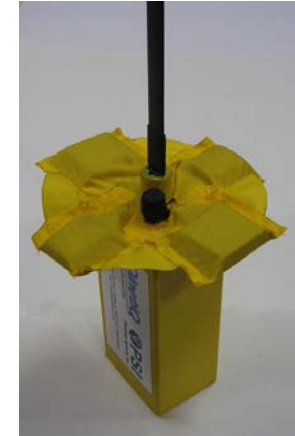
Micro Air-launched Expendable Wave Buoy + Current (MAXWB+C)

DEVELOPMENT:

- Redesign of the QNA MAXWB
- Used proven wave data collection and processing techniques
- Added GPS for position and current calculation
- Improved sea surface temperature accuracy
- Provided Iridium and barometric pressure expansion capability

OPERATION:

- Expendable sensor (cost < \$2K)
- Deployed from aircraft or ship
- Activated by salt water switch
- Waves data available 10 minutes after deployment
- Processed data transmitted via line of site UHF radio
- Transmission range up to 30 nm (to aircraft)
- Compatible with AVAPS receiver as well as low-cost COTS receiver



RANGE AND ACCURACY:

- Wave Height ± 0.25 m, 0.25 to 0.99
 $\pm 10\%$, 1 to 10 m
- Dominant/Average Period ± 0.5 s, 1 to 25 s
- Sea Surface Temperature $\pm 0.2^\circ$ C, -5° to $+40^\circ$ C
- Surface Current ± 0.1 m/s

SPECIFICATIONS:

- Transmitter 400-406 MHz (UHF)
AVAPS/PADS/COTS
- Weight 433g
- Dimensions 5.0 x 6.4 x 20.0 cm
- Operating Temperature Range -40° C to 40° C
- Battery Life > 12 hrs

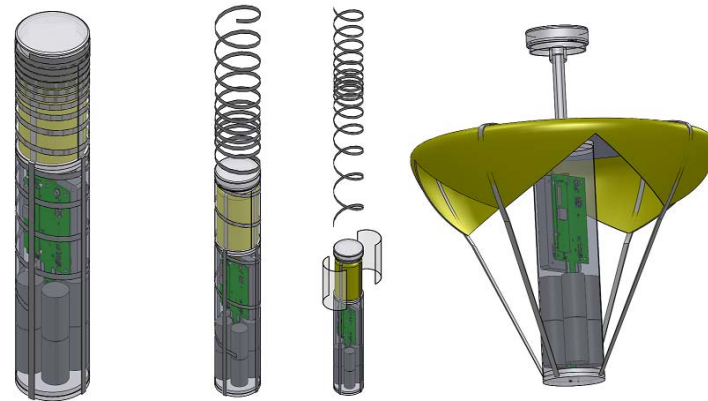
Proposed Iridium Micro Air-launched Expendable Wave Buoy (iMAXWB)

DEVELOPMENT GOALS:

- Expand MAXWB+C design
- Improve GPS antenna position and function
- Integrate Dual Iridium/GPS antenna
- Provide LOS and Iridium communications
- Conform to NCAR dropsonde form factor
- Extend buoy battery life

OPERATION:

- Expendable sensor (cost < \$3.5K)
- Deployed from aircraft or ship
- Activated by salt water switch
- Waves data available 10 minutes after deployment
- Processed data transmitted via line of site UHF radio and Iridium modem
- Compatible with AVAPS receiver as well as low-cost COTS receiver
- Launch and leave



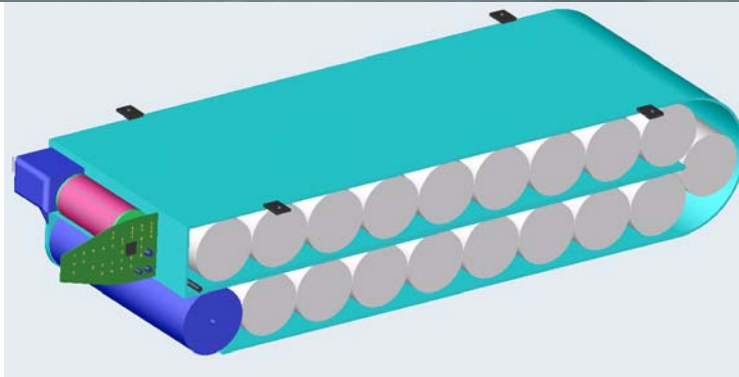
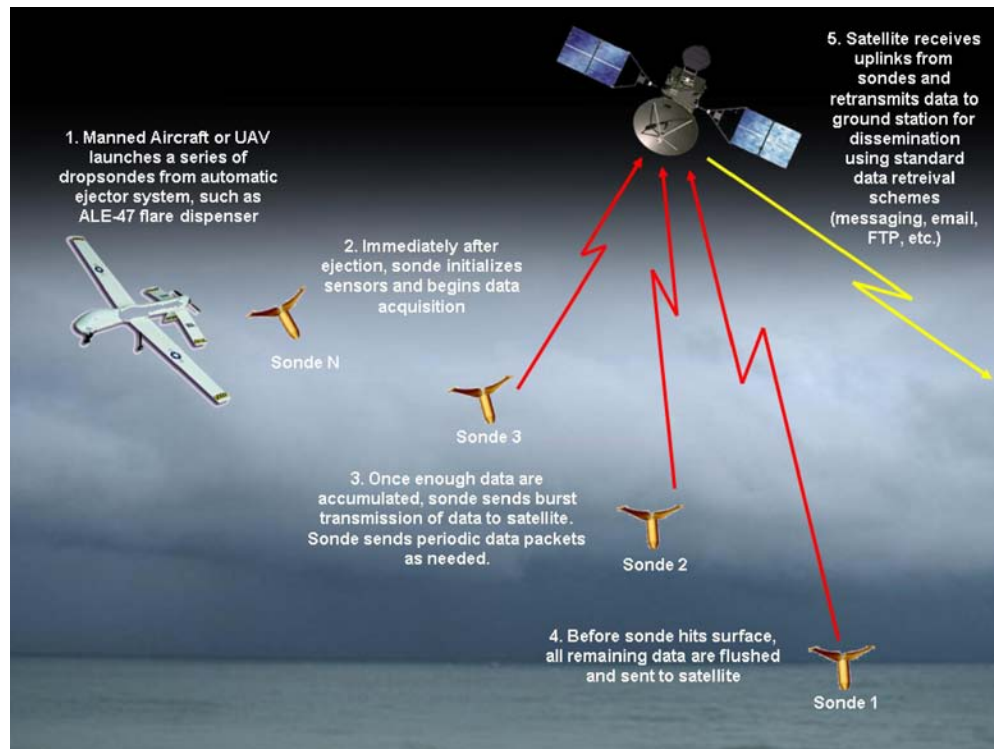
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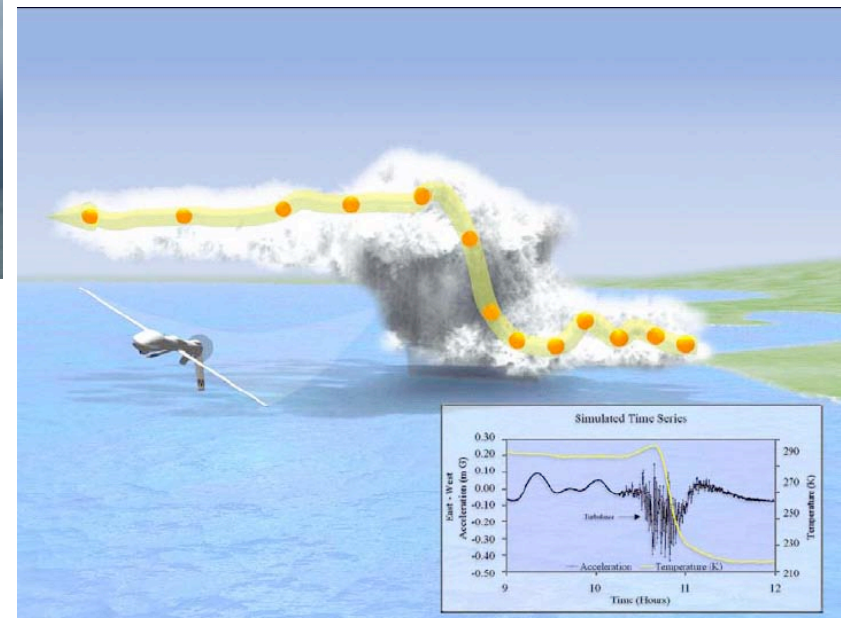
- Transmitter 400-406 MHz (UHF)
Iridium 9601 SBD Modem
- Weight 433g
- Dimensions 5.0 x 6.4 x 20.0 cm
- Operating Temperature Range -40° C to 40° C
- Battery Life > 7 days

Next-Gen Automated Dropsonde System w/ SATCOM



Design Challenge:

- Automated dispensing
- Launch every 10 seconds
- Track 40 sondes simultaneously
- Communicate data via satellite
- SST option
- Multiple form factors

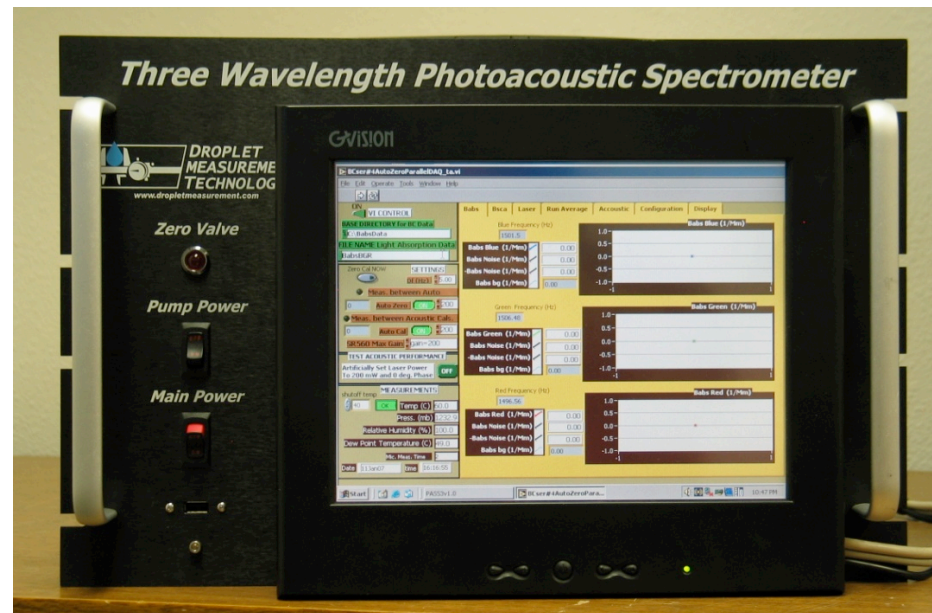


Cloud Droplet Probe (CDP)



- Measures cloud particles in the 2 - 50 μm range
- Particle-sizing and concentration histograms
- Light source: 660 nm, 50 mW diode laser
- Concentration range: 0 - 5,000 particles/cm³
- Airspeed range 10 - 200 m/sec, altitude limit 50,000 ft

Photoacoustic Soot and Aerosol Sensor, Three Wavelength (PASS-3)



- Direct measurement of aerosol light absorption and scattering
- *In situ* measurement without filters, autonomous operation
- 405, 532 and 781 nm laser wavelengths, simultaneous measurement
- Scattering measurement responds to all particle types
- Real-time readout of aerosol mass loading

Single Particle Soot Spectrometer (SP2)



- Only probe in the world that directly measures black carbon (soot) in individual aerosol particles
- Single-particle scattering of non-absorbing particles
- Two-color incandescence measurement of individual light-absorbing particles
- Direct measurement of black carbon mass; spherical equivalent diameter derived from mass

Ultra-High Sensitivity Aerosol Spectrometer, Airborne (UHSAS-A)



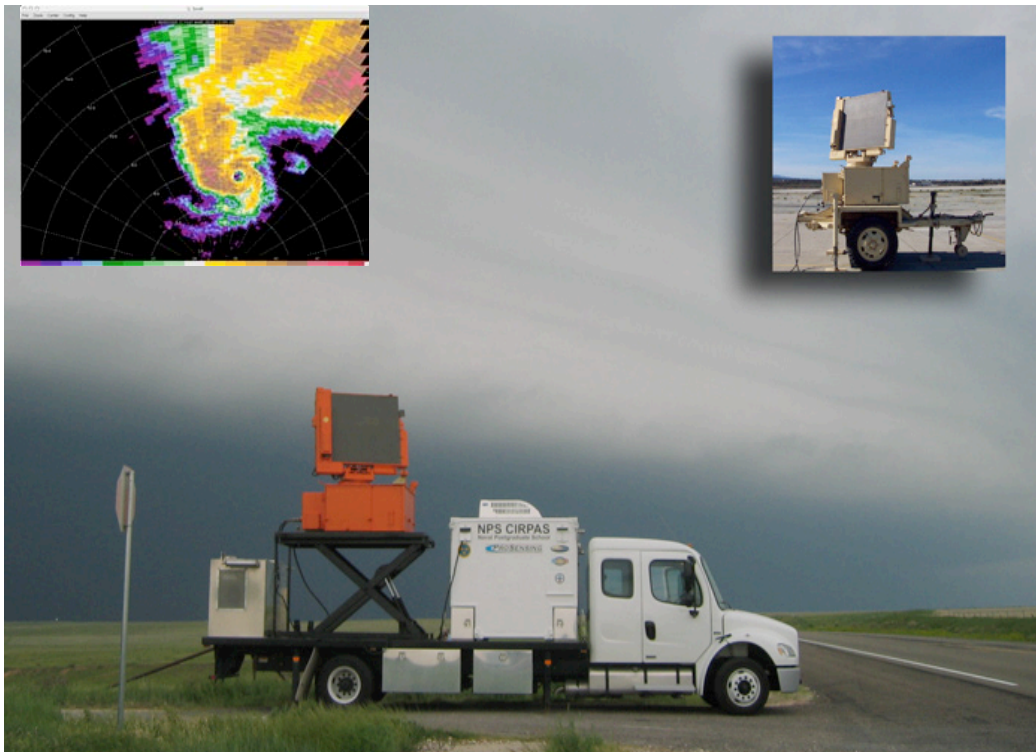
- Measures aerosols in the 60 nm to 1 μm range
- Maximum count rate: 3000 particles/sec
- 100-bin resolution
- Sample flow rate: 10-100 cc/min
- Data sampling rate: up to 10 Hz

Artium Technologies, Inc. Phase Doppler Interferometer
(PDI) Extended Range Flight Probe, **PDI ExR FP**

Measures drop size: 0.5 to 1000 μm and Liquid Water Content (LWC)



- Based on the phase Doppler interferometry (PDI) method
 - Drop size measurements based on the light wavelength
 - Unique sinusoidal Doppler signals allow reliable detection and measurement of each droplet using Fast Fourier transforms (FFT)
 - **Does not** require frequent calibration in the field
 - Measures drop size, velocity, number density, and liquid water content



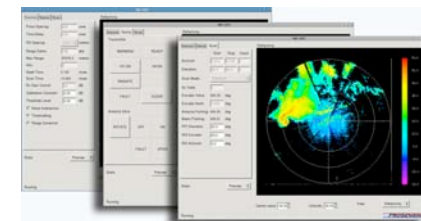
MWR-05XP

Mobile Weather Radar,

operational use from 2005,

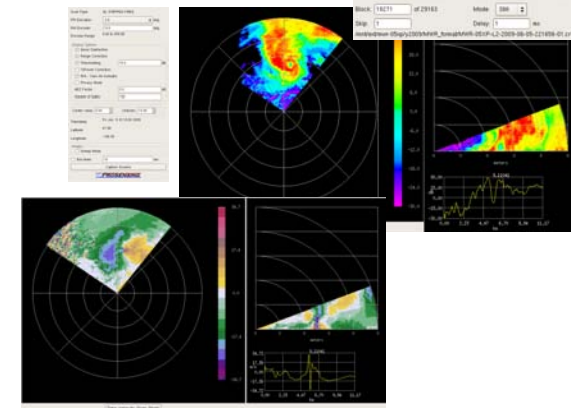
X-band, Phased Array

Radar Control GUI Software



Written in client-server configuration allowing for full control and operation from a remote location – anywhere on Internet

Real Time PPI and RHI Display of Calibrated Reflectivity and Velocity



MWR-05XP radar parameters			
	Signal-to-Noise ratio	Velocity error	
Transmitted pulse width	1 ms	0 dB	2.4 m/s
Pulse Repetition Period	400 ms	10 dB	0.637 m/s
Integration time	9 ms	20 dB	0.197 m/s
Number of Samples	10	30 dB	0.062 m/s

Parameter	Value
Transmitted frequency	X-Band
Transmit power	15.13 kW (peak) 240 W (average)
PRF	10 kHz (max)
Transmitted pulse width	1 μ s
Antenna type	Mechanically rotated electronically scanned phased array
Azimuth BW	1.8°
Mechanical Azimuth Scan	360°, 30 RPM
Electronic Azimuth Back-Scanning	3° to 12°
Elevation BW	2.0°
Elevation Scan	-18° to 55° relative to the horizon
Range Resolution	150 m
Range Sampling Interval	75 m
Sensitivity	~ -15 dBZ@10 km

Scanning Strategies

First mobile electronically scanned phased array weather radar
(...still the fastest ...)



MWR-05XP capabilities critical for rapid scanning:

- Rapid mechanical scanning in azimuth (up to 180 degrees per second)
- Frequency Agility
 - "Frequency Hopping"
 - ✓ Provides independent samples *within* de-correlation time of the weather target
- Electronic (fast) scanning
 - Pulse-to-pulse electronic scanning in elevation
 - Limited (<12°) pulse to pulse back-scanning in azimuth
 - ✓ Eliminates beam smearing in azimuth

STF-SP STEPPED FREQUENCY STEPPED SPIRAL

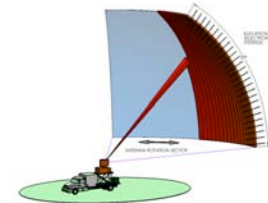
Similar scan to WSR-88D but faster

1. Two pulses pre dwell
2. CW rotation covering full 360° azimuth @ 180° per second
3. 10 step frequency hopping [azimuth back-scanning]
4. Step in elevation after completing full 360° scan

- ✓ Reflectivity
- ✓ Pulse pair velocity

Typical volume scan parameters:

- Azimuth
 - sector: 360°
 - step: 1.62°
- Elevation
 - sector: 0° to 20°
 - step: 1.67°
- Antenna rotation speed: 180°/s
- Volume scan rate: **24 seconds**



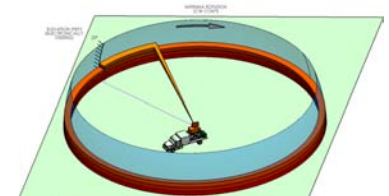
SCANNING MODES

STF-SE STEPPED FREQUENCY ELEVATION SCAN

- Two pulses pre dwell
- Electronic step scanning in elevation
- 10 step frequency hopping
- CW or CCW rotation covering desired sector in azimuth
 - Reflectivity
 - Pulse pair velocity

Typical volume scan parameters:

- Azimuth
 - sector: 90°
 - step: 1.62°
- Elevation
 - sector: 0° to 20°
 - step: 1.67°
- Antenna rotation speed: 150°/s
- Volume scan rate: **6 seconds**

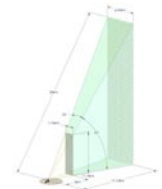


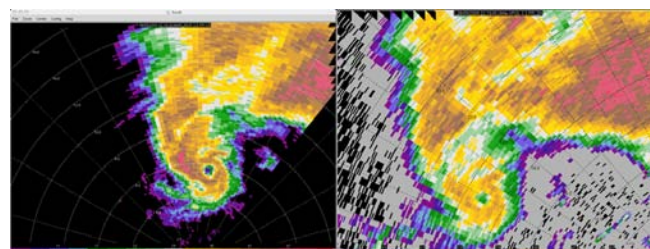
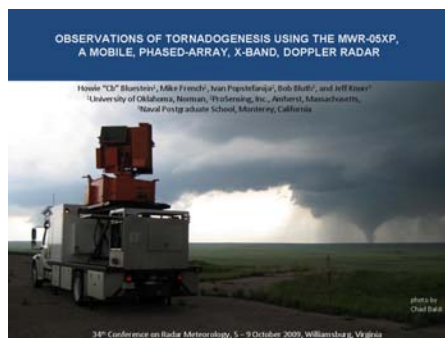
RAS-SP RASTER SCAN

- Multiple (up to 256) pulses pre dwell
- Electronic step scanning in elevation
- Electronic step scanning in azimuth
 - limited to maximum 80 sector
 - or
- CW or CCW rotation covering desired sector in azimuth
 - Doppler spectra

Typical volume scan parameters:

- Azimuth sector: 350°
- Elevation sector: 0° to 55°
- Hits per dwell: 64
- Dwell time: 16.1 ms
- Antenna rotation speed: 2.340°/s
- Volume scan rate: **15 seconds**





2.5°, Z, 2219:19 UTC
MWR-05XP

2.3°, Z, 2219:00 UTC
UMASS X-POL

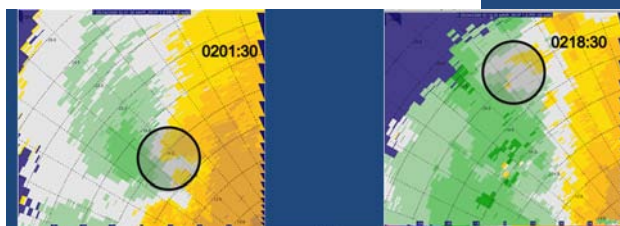
5 JUNE 2009 GOSHEN COUNTY, WY

MOTIVATION FOR RAPID-SCAN RADARS

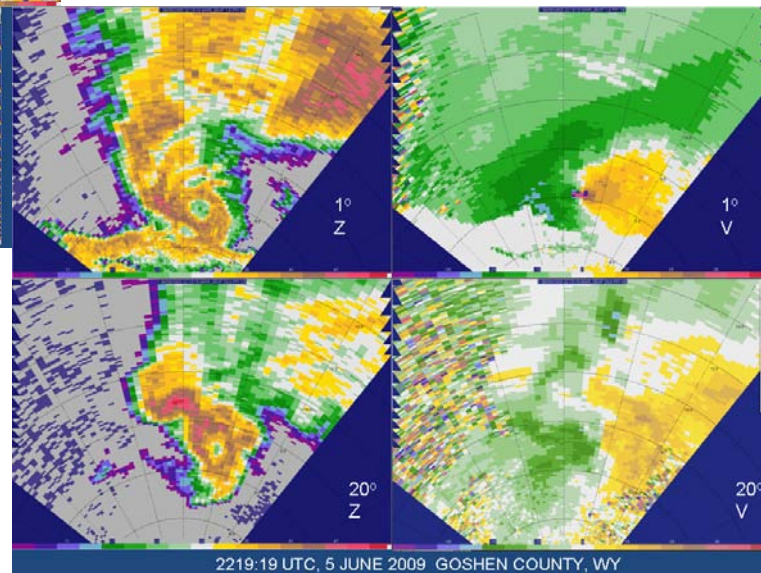
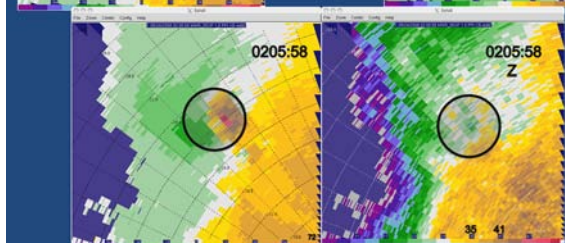
- ADVECTIVE TIME SCALE FOR TORNADOES $\sim 2\pi r_c/V$
 $\sim 2\pi (100 \text{ m})/60 \text{ m s}^{-1} \approx 10 \text{ s}$
- SUPERCELL UPDRAFTS $\sim 50 \text{ m s}^{-1}$ ADVECT VORTICITY, CLOUD PARTICLES, & SMALL HYDROMETEORS UPWARD $\sim 5 \text{ km}$ (\sim HALF THE DEPTH OF THE PARENT STORM) IN $\sim 100 \text{ s}$: TO FOLLOW EVOLUTION IN THE VERTICAL MUST VIEW STORM EVERY $\sim 10 \text{ s}$
- SIMILARLY FOR DOWNDRAFTS (AND DESCENDING REFLECTIVITY CORES), BUT DOWNDRAFTS MAY BE WEAKER

OTHER RAPID-SCAN RADARS

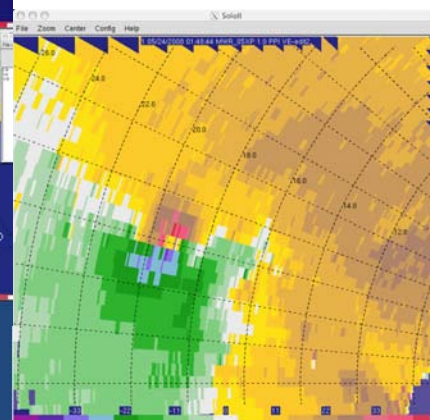
- NWRT PAR (NORMAN) S-BAND ELECTRONICALLY SCANNING (FIXED-SITE) $1.5 - 2^\circ$ BEAM
- RAPID DOW (CSWR) X-BAND HYBRID ELECTRONIC - MECHANICALLY SCANNING (MOBILE) $\sim 1^\circ$ BEAM
- RAPID X-POL (OU/PROSENSING; UNDER CONSTRUCTION) X-BAND, POLARIMETRIC, MECHANICALLY SCANNING (MOBILE) $\sim 1^\circ$ BEAM



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2219:19 UTC, 5 JUNE 2009 GOSHEN COUNTY, WY



Twin Otter "D" Check



Includes but is not limited to the following:

- internal structures otherwise inaccessible for corrosion and/ or stress fractures
- overhaul of life limited hydraulic components
- overhaul of life limited electrical components
- overhaul of airframe components, landing gear
- payload electrical system re-worked and improved while the wings are removed
- tail removed for mandatory corrosion inspections
- structural modifications to extend the life of the wing box structure.
- engine change is also being performed

Twin Otter Schedule 2010

(as of 10/21/09)

January

February

March

April

May

June

July

August

September

October

November

December

1

8

15

22

29

Federal holiday:

Weekend:

Integration:

TBD

Ferry flight:

Projects:

Albrecht – BACEX (confirmed)

Seinfeld – CalNex (confirmed)

Melville – HiRes (confirmed)